EXHIBIT 18

IN THE UNITED STATES DISTRICT COURT

SOUTHERN DISTRICT OF NEW YORK

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CARNEGIE INSTITUTION OF
WASHINGTON AND M7D CORPORATION,

Plaintiffs,

vs. CASE NO: 20-CV-189 (JSR)

PURE GROWN DIAMONDS, INC., and
IIA TECHNOLOGIES PTE. LTD. d/b/a
IIA TECHNOLOGIES,

Defendants.

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CARNEGIE INSTITUTION OF
WASHINGTON and M7D CORPORATION,

Plaintiffs,

vs. CASE NO: 20-CV-200 (JSR)

FENIX DIAMONDS, LLC,

Defendants.

****

The video deposition of YOGESH K. VOHRA, Ph.D., taken remotely via Zoom videoconference with the witness located in Washington, DC, on July 31, 2020, commencing at approximately 10:00 a.m. ET

Reported by:

L. ALAN PEACOCK, RDR, CRC, CCR

JOB NO. 48951

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A P P E A R A N C E S (Continued)

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- - -

E X A M I N A T I O N

DEPOSITION EXHIBITS

EXHIBITS (Continued)

EXHIBITS (Continued)

Exhibit 109 Declaration and Power of Attorney .... Page 173
for Patent Application"

Exhibit 110 Combined Declaration for Patent ...... Page 173
Application and Power of Attorney"

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THE VIDEOGRAPHER: Here begins Volume I, Disk 1, in the video deposition of Yogesh Vohra taken in the matter of, Case 1, Carnegie Institution, et al., versus Pure Grown Diamonds, et al. We also have Case 2, which is Carnegie Institution, et al., vs Fenix Diamonds, et al., in the United States District Court, Southern District of New York. 09:07:48 09:07:49 09:07:51 09:07:58 09:08:02 09:08:07 09:08:07 09:08:08

Today's date is July 31. The time is 9:08 a.m. This deposition is being held remotely by Live Litigation. We're physically recording in Lexington, Kentucky. 09:08:10 09:08:13 09:08:17 09:08:21

The court reporter today is Alan Peacock, and the videographer today is myself, Carrie Howard. Both are presenting on behalf of Henderson Legal Services. 09:08:23 09:08:25 09:08:29 09:08:31

Will counsel please introduce themselves and state whom they represent. 09:08:33 09:08:35

MR. LONG: This is J. Preston Long for the defendants IIA Technologies PTE Limited and Pure Grown Diamonds, Inc., in the 189 matter. 09:08:38 09:08:41 09:08:46

MS. FOWLER: This is Sarah Fowler of Perkins Couie, on behalf of the plaintiffs Carnegie Institution of Washington and M7D Corporation. And with me is Joseph Ricigliano. 09:08:54 09:08:55 09:08:57 09:09:01

THE VIDEOGRAPHER: All right. And will the court reporter now please swear in the witness. 09:09:12 09:09:12 09:09:12

MR. AIRAN: There are more appearances. This is David Airan on from Leydig, Voit & Mayer on behalf of Fenix Diamonds, LLC, in the 200 case. And with me is Max Snow, also of Leydig Voit & Mayer, also representing Fenix Diamonds, LLC. 09:09:12 09:09:12 09:09:14 09:09:17 09:09:21 09:09:25

MR. MELLON: Although you can't see me, this is David Mellon, M-E-L-L-O-N, counsel for Dr. Vohra. 09:09:27 09:09:27 09:09:32

THE VIDEOGRAPHER: Okay. Now, will the court reporter please swear in the witness. 09:09:40 09:09:41

THE COURT REPORTER: My name is Alan Peacock with Henderson Legal Services. I am an Alabama Certified Court Reporter. My license number is AL013, and my license is available for inspection. 09:09:43 09:09:43 09:09:43 09:09:43 09:09:43

At this time, do all parties agree to waive any objection now or in the future to the reporter swearing in the witness remotely? 09:09:43 09:09:43 09:09:43

Please so indicate. 09:09:43

MR. LONG: No objection here. 09:09:43

MR. AIRAN: No objection on behalf of 09:09:43

Fenix. 09:09:43

THE COURT REPORTER: Thank you. 09:09:43

I would ask the witness to please raise your right hand and face the camera. 09:09:43 09:09:43

YOGESH K. VOHRA, PH.D., 09:09:43

the witness, having been first duly sworn to speak the truth, the whole truth, and nothing but the truth, testified as follows: 09:09:43 09:09:43 09:09:43

EXAMINATION 09:09:43

BY MR. LONG: 09:10:32

Q. So let me first start, Dr. Vohra, by saying thank you for being here today. There are probably any number of things you would rather be doing today; so for what it's worth, we appreciate your time. 09:10:33 09:10:36 09:10:39 09:10:41 09:10:43

Is this your first deposition? 09:10:44

A. That's correct. 09:10:47

Q. Okay. So I just want to run through a few guidelines to make sure everything goes smoothly. I think that the court reporter has already mentioned it's best if we don't talk over one another so that the court reporter can take down our conversation and there's no cross talk. Is that okay? 09:10:49 09:10:52 09:10:55 09:10:57 09:11:00 09:11:02

A. That's fine. 09:11:07

Q. From time to time, I probably will ask a 09:11:09

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power; right?

A. **That's correct.**

Q. If you want to grow over larger areas -- strike that.

What effects does the microwave power density have on growth characteristics of the diamond?

A. **I think it's really a complicated question, but in general I would say that the higher growth rates have been achieved when the pressure is around 200 torr. And that's very low. Most of the gem manufacturing has taken place at 200, 250 torr.**

So -- but another parameter is, of course, the gaseous chemistry. So it's really a complicated, complicated thing to consider what effect different parameters have. There's multiparameter space, and generally it would require a lot of innovations, and that work which was carried out in committee which achieved the gem diamond growth.

Q. But in terms of the microwave power density, did your students find that a higher microwave plasma density improved the growth rate?

A. **I don't think we have really -- if you look over Dr. McCauley's thesis, we really never --**

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most of the work was done on, as I said before, on angles which are only human hair sized tip. So it's very, very hard to extrapolate these results to the larger work done later on.

Q. What about Mr. Israel and Dr. Yan? Did they find higher input densities led to improved growth rates?

A. **Again, those were really very fundamental studies looking at the factor of temperature and substrate geometry. So I would say those were really -- the work done later on by Dr. Yan at UAB and Carnegie that resulted in the breakthrough for gem diamond growth.**

Q. My question is not about, you know -- I'm not sure what you mean by "the breakthrough." My question is just -- let me ask it this way: Is it your testimony that your students did not find that higher microwave power densities led to improved growth rate?

A. **Higher power density -- I don't think we ever really talked about higher power density. We should look into this, and we never really talk about power per cc. This is a really very fundamental plasma parameter study. We never talked about plasma density in this, so that's why I really**

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cannot extrapolate.

Q. Okay. I will turn to -- I'm turning to what is marked page 142 of Vohra Exhibit 3, and it begins down at the bottom of the page.

It says "Reported linear growth rates have been shown to depend on areal power density and to a lesser extent" -- and he goes on to page 144 -- "to a lesser extent on pressure. As shown in Figure 4.3 the growth rate scales roughly linearly with areal power density," and shown on the previous page, page 143. Do you understand what Dr. McCauley is talking about there?

A. **I think these are really not the actual plasma densities. He talks about areal, and he is only talking about one dimension, which is along the axis of that substrate. So it's really not a true measure of the power density where you photograph the plasma, have the input power and have the plasma density.**

Q. What are the units of power density in a microwave plasma?

A. **It could be for -- an example would be a kilowatt per cc for -- I don't recall what this Péclet number is here. I think this is something different. It's not the plasma density.**

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Q. Okay.

A. **With some other plasma jets and plasma torches, so this is really a different -- a different thing to compare.**

Q. So you disagree with the statement that reported linear growth rates have been shown to depend on areal power density and, to a lesser extent, pressure? That's an incorrect statement in your view?

A. **I would not say incorrect. I think it does not present the whole picture in terms of what areal density really means. If it's only one dimension of the plasma, it really doesn't capture the whole picture. I'm not saying this correlation is incorrect; however, this is not the complete --**

Q. Is the areal power density of the plasma near the substrate surface important?

A. **Could you repeat that question, please?**

Q. Is the areal power density of the plasma adjacent to the substrate surface important?

A. **Yes, it is. Yes.**

Q. Why is that?

A. **For the simple reason is that most of the chemical reactions which lead to diamond growth depends on the concentration of activated species**

near the plasma surface and near the substrate surface.
Q. And so does the areal density of the microwave plasma near the substrate surface affect the growth rate?
A. I don't really recall this argument fully here. I really don't -- whether we ever quantified the areal plasma density here. I think this is just a statement without quantification. That was not the focus of this thesis anyways.
Q. Putting aside the statement here in the thesis, is it your understanding that the areal power density adjacent to the substrate surface affects the growth rate?
A. No. It might be -- and I think it's the plasma density where you somehow count for the total volume of the plasma -- I'm talking about the areal, which is one dimensional. That's my technical opinion.
Q. And how does the density of the microwave plasma affect the growth rate?
A. I'm sure -- they are stirring, which has to have looked at, you know, different process parameters, like pressure, substrate temperature, microwave power. So it's really a multiparameter

10:10:35 10:10:40 10:10:42 10:10:49 10:10:53 10:10:57 10:11:00 10:11:08 10:11:11 10:11:15 10:11:18 10:11:20 10:11:23 10:11:27 10:11:28 10:11:33 10:11:37 10:11:42 10:11:48 10:11:48 10:11:55 10:12:00 10:12:11 10:12:18 10:12:23

space, and also it depends a lot on the reactive -- I would hesitate to make a generalized statement because it's so design specific.
Q. So if you change one thing in the system, it might affect other things?
A. That's correct. I think this is really -- that's why, as you see, there's a lot of optimization which goes into developing the process.
Q. And so if you change, say, the pressure, it might completely affect the process and get a different growth, different properties of the diamond, different growth rate?
A. That's correct. Generally speaking you can make generalizations. But it also depends on the substrate geometry as well. And one can draw some general conclusions about pressure and power. But I think that's specific. Those depend really on the whole unit, not just one thing.
Q. Why does the shape and geometry of the substrate matter?
A. That is a very complicated question. And I think it's -- it's to do with the fact, you know, how the actual species react and the surface and also how the different exposed surfaces of diamond are cooled; so it's really a very different question

10:12:28 10:12:35 10:12:40 10:12:43 10:12:46 10:12:48 10:12:53 10:12:56 10:13:01 10:13:03 10:13:09 10:13:11 10:13:13 10:13:14 10:13:17 10:13:21 10:13:28 10:13:32 10:13:36 10:13:38 10:13:40 10:13:44 10:13:49 10:13:56 10:13:59

to address.
Q. I'm turning back to -- this is page 103 in Vohra Exhibit 3. It's Figure 3.4 entitled an -- I'm sorry. Page 104 on Figure 3.5, titled "The overall design of the substrate stage as mounted to the conflat flange which forms the floor of the deposition chamber."
Is this the design of the substrate stage and the 1.2-kilowatt system?
A. Yes.
Q. Could you just walk me through this diagram in terms of what we're seeing and how it works?
A. You see the tube which is running through the center? It carries the water upward, and it kind of sprayed it against the copper block for cooling that. And then the outer jacket captures the water which is returning, and that's what the cooling water return is.
Q. And then up here at the top, there's a brass insert, copper heat sink, silver soldered seal, copper heat sink insert and molybdenum screw. Could the walk us through what those are?
A. The moly screw is what we call the substrate holder. So to cool the moly substrate

10:14:03 10:14:15 10:14:26 10:14:33 10:14:40 10:14:44 10:14:46 10:14:49 10:14:51 10:14:56 10:14:57 10:14:58 10:15:01 10:15:01 10:15:03 10:15:09 10:15:14 10:15:17 10:15:21 10:15:24 10:15:28 10:15:35 10:15:44 10:15:46 10:15:48

holder, we turn it into the copper block, and the copper block is cooled.
Q. So the cooling in its design happens from water cooling at the copper stage, which is in thermal contact with the moly screw?
A. That's correct.
Q. Then the substrate sits in or on the moly screw; right?
A. And there's a lot of innovation around the moly screw design itself; so --
Q. Could you just explain what you mean?
A. I mean, you have your moly screw. You can have a recessed stage for a diamond to sit in -- you can have a diamond sitting on the flat stage, and you can clamp it to cool down the edges of the diamond; so there are a lot of variations of that technology.
Q. Do you remember which ones of those your students used in the 1990s?
A. No. He just used the flat screw here.
Q. What about your other students? Were there different moly designs?
A. Yes. I'm sure there were different thesis projects we had experimented -- Dr. Yan did design some of the solutions for a moly substrate.

10:15:53 10:15:58 10:15:59 10:16:06 10:16:10 10:16:14 10:16:14 10:16:18 10:16:20 10:16:24 10:16:27 10:16:33 10:16:35 10:16:38 10:16:43 10:16:45 10:16:48 10:16:49 10:16:52 10:16:54 10:16:57 10:16:59 10:17:01 10:17:04 10:17:09

that. Because plasma species do diffuse even if you're a couple of millimeters above; so I don't know how much a trade-off is in terms of the growth rate and the conditions with that.

Q. But the temperature is different? You agree with that; right?

A. Yes. The temperature is definitely different. You probably would have to do more cooling of the substrate.

Q. More cooling -- so it requires more cooling if the plasma is in direct contact?

A. If you want to maintain the same temperature.

Q. Any other differences in having the plasma in direct contact versus above in terms of the physics?

A. No. Not that I can think of without having all of the qualitative data in front of me.

Q. Turning back to the exhibit, the second difference here it mentions is "The total gas flow rate that we use is 500 sccm, higher than that used in most other systems, about 100 sccm, by approximately a factor 5."

What is the significance of using more gas flow?

A. Once we increase the hydrogen gas flow, we have to up the methane; so it does release high growth rate having more carbon species. If you keep the methane to hydrogen ratio the same. So if you have hydrogen flowing at a high rate, you have to -- if you keep the same ratio, you have to up the methane, and then that would give rise to, you know, possibly high growth rate.

Q. Any other significance to the higher flow rates?

A. No. It really depends on the specific reactor system we used. For this system, we used 500 sccm. And it depends on your capacity and a lot of other factors. It depends on the reactant as well.

Q. But just in general, if I understand you correctly, increasing the flow rate means increasing the amount of material you're delivering and, therefore, it would increase the growth rate; right?

A. Yeah. But I think really the question is not that much about -- of course the hydrogen is important, but I think it also depends on the activated carbon species of the plasma. So whatever you give rise to higher activated species in the plasma, would give rise to increased growth rate.

Q. So, in other words, if you were using 100 sccm total flow that was, say, 5 sccm methane, 95 sccm hydrogen, if you went to 500 sccm total and you increased the methane accordingly, I guess it would be -- what? -- 25 sccm to 475 sccm of hydrogen, and then that would -- I'm just trying to put a specific example on what you're saying.

You increase -- you keep the ratio the same but you increase the total flow?

A. Yeah. I think one has to be a little bit careful. Because increasing the methane also changes how diamonds grow differently on different surfaces. So there's a little bit of a complication there on the diamond growth process itself.

So I would not say like you would expect a linear increase in growth rate because the diamonds grow differently on (100) and (111) surface. So if you go into a regime of carbon concentration, then you may end up not growing much on one surface. So it's really a multiparameter space; so it does not really -- changing one parameter can give you the new answer.

Q. So to increase the growth rate, but you're just not sure about how much?

A. Yes. But, you know, I worry about what --

the technical jargon -- we call it alpha parameter -- for the diamond growth, which is the growth on (100) versus (111) surface. So I think one has to really see how that changes, because most of the new gem diamond growth is carried out on 100 cycles.

Q. Checking back here, the third difference, it says "Our typical operating pressure is 90 torr; whereas, most systems operate in the neighborhood of 25-40 torr."

What is the significance in increasing the pressure?

A. That definitely has an increase in the growth rate.

Q. And it says here that Dr. McCauley was able to achieve growth rates on the order of 50 to 400 microns per hour higher than ever reported in the MPCVD system. Is that an accurate statement?

A. I think the caveat there, I think there are two caveats to this. One is this was really on a very small surface area, and I'm not sure in this case we ever were able to get just the diamond twinning in these conditions. So this was really not a gem diamond growth rate.

Q. Forget about gem diamond. I'm just asking

A. Yes. 11:28:02
Q. So is it your understanding that that pyrometer is a Mikron Model M77LS pyrometer? 11:28:03
A. Yes. 11:28:11
Q. Okay. Turn now to Vohra Exhibit 6. You should see it on the screen here. 11:28:13
Have you seen this document before? 11:28:27
A. I might have. 11:28:31
Q. Is this picture down here the Model M77LS laboratory version -- is this the pyrometer you used in the 1.2-kilowatt system? 11:28:36
A. Yes. That's correct. 11:28:47
Q. So this is the pyrometer that you used to measure substrate temperatures? 11:28:57
A. Yes. 11:29:06
Q. I'm sorry. What was your answer? 11:29:09
A. Yes. 11:29:11
Q. And the 2-millimeter sampling diameter, what does that refer to? 11:29:15
A. That is reference to the area from which the temperature reading is recorded. 11:29:20
Q. And is that -- is that something you can adjust or is that something dictated by the manufacturer? 11:29:33
A. That is limited by the optics on the 11:29:44

particular model that we were using. 11:29:49
Q. Okay. And here you describe -- this is, again, on page -- this is page 27 of Vohra Exhibit 8. It mentions "The substrate is placed on a step which allows the substrate to be elevated into the plasma and heated from all directions without becoming too hot." 11:29:52
Could you just describe how the samples were mounted in these experiments? 11:30:25
A. This would be directly sitting on top of the moly holder. 11:30:30
Q. So the sample would be before inserted directly into the plasma? 11:30:37
A. Yes. 11:30:43
Q. Would you turn to page 34 of Vohra Exhibit 8. Down here near the bottom, Subsection C, it says "a pressure study." 11:30:52
What did Mr. Israel study in terms of pressure? 11:31:11
A. I think, if I recall, he was looking at the twins and the growth rate by weighing the crystal before and after. 11:31:21
Q. And he tried different pressures as part of his studies? 11:31:34
A. Yes. 11:31:39

Q. And do you see this on the next page -- sorry -- page 35 of Vohra Exhibit 8, beginning with the first full paragraph: "The results from our four experiments show the diamond growth rate and twin formation to depend greatly on variations in reactor pressure. The reactor pressure was increased from 60 to 200 torr. Diamond growth rate increased approximately 10-fold while penetration twin formation was nearly eliminated." 11:31:45
Do you see that? 11:32:14
A. Yes. 11:32:14
Q. It says "The maximum growth rate attained in any of the pressure experiments was" -- for example, DP17 is comparable to the standard HPHT rates. Do you see that? 11:32:14
A. Yes. 11:32:30
Q. Do you remember that result from these experiments? 11:32:31
A. Yes, I do. As I recall, I don't think we were -- he said nearly eliminated. I think that was critical. I don't think we ever got a twin-free diamond in this set of experiments. The reason I say that is to really show that it's twin free, you really have to use x-rays and get what we call the rocking curve, which will tell you whether you have 11:32:35

a mono crystal or if you have more than one crystal. 11:33:09
So we were still not there when Mr. Israel was working on this problem, and we never did the rocking curve measurements on the crystal. That's why I think that term "nearly eliminated" was significant. 11:33:14
Q. But they were nearly eliminated, so there weren't substantial twins? 11:33:33
A. Yeah, but, you know, in this field, even if you know there is one twin, then it's not a single crystal. 11:33:37
Q. Even one twin is not single crystal? 11:33:44
A. So that's why, I think, later on we realized that we have to do the rocking curve measurements by x-ray technique to show the quality of crystal. Because all of the other visual observations are really qualitative about the crystal quality. 11:33:47
Q. All right. Some things you can just look at and tell if it's single crystal or not? 11:34:07
A. It's really hard with just a visual inspection. I mean, you could tell from the growth steps and the surface appearance. But eventually, you know, to check the crystalline quality, you have to put it on the x-ray machine and tilt it to show 11:34:17

that there's only one grain of diamond. That's the key. 11:34:35 11:34:41
Q. What if you saw black spots on the surface? 11:34:41 11:34:43
A. That's definitely twinning. 11:34:44
Q. I'm sorry? 11:34:49
A. That's definitely twinning. It's not a single crystal. 11:34:50 11:34:52
Q. So you don't need X-ray -- 11:34:55
A. Visually, you can tell. I'm talking about using X-ray when visually you think it's free, but still you need to verify it by doing x-ray diffraction. 11:34:58 11:35:01 11:35:05 11:35:06
Q. And you would agree when you can see those black spots and things that it's definitely not single crystal? 11:35:09 11:35:12 11:35:13
A. Correct. 11:35:15
Q. Okay. I will turn to the next page. This is Figure 11. Is this some of the examples that were grown? 11:35:20 11:35:24 11:35:29
A. Yes. 11:35:30
Q. And can you tell that there's -- that it's not single crystal by looking at these figures? 11:35:31 11:35:33
A. Yes. By example, if you look at A, you do see the black marks on the surface. And same as for 11:35:37 11:35:40

B. Even though in C, you see that clear thing in the center, but you see a lot of twinning on the side. So there are adjusting science experiments, but they have not yet achieved the quality of even one crystalline growth. 11:35:46 11:35:50 11:35:53 11:36:00 11:36:03
Q. Okay. So sample C, this rim here indicates that it's just not single-crystal growth? 11:36:05 11:36:07
A. No. I don't believe it is, particularly using the X-ray criteria -- and that's what the title says, you know, 200 torr, few twins. 11:36:12 11:36:14 11:36:18
Q. Right. 11:36:25
A. Even on the side. 11:36:25
Q. Right. All of the stuff here on the side. This would be not single-crystal? 11:36:26 11:36:29
A. (No response.) 11:36:33
Q. These portions around the edge of figure 11-C would be not single-crystal; correct? 11:36:35 11:36:38
A. Yes. Because you are not seeing your sharp facets there. 11:36:44 11:36:52
Q. I will turn to page 38 of Exhibit 8, Table 2. Is this a table summarizing Mr. Israel's pressure experiments? 11:37:00 11:37:03 11:37:09
A. Yes. 11:37:11
Q. And so as the pressure increased from 60 to 90 to 150 to 200 torr, what was the trend and the 11:37:15 11:37:19

growth rate? 11:37:26
A. The growth rate is obviously going up with increasing pressure. 11:37:26 11:37:34
Q. And what was the trend in quality here? 11:37:36
A. The quality is improving, but as I mentioned earlier that it is not a monocrystalline stellate growth. 11:37:42 11:37:44 11:37:46
The quality is definitely improved. 11:37:46
Q. So if somebody wants to a grow high-quality diamond at a high-growth rate, they would at least understand from this that a higher pressure would be a good idea; right? 11:37:52 11:37:54 11:37:58 11:38:00
A. Yes. 11:38:04
Q. And turning to the end of Mr. Israel's thesis, page 60 of Exhibit 8, he mentions "Here some suggestions for future work would be to have better control of the substrate temperature during growth experiments, a better thermal contact between the diamond substrate and molybdenum stage is necessary to maintain a fairly stable teach reading." 11:38:36 11:38:41 11:38:50 11:38:55 11:38:58 11:39:01 11:39:04
Do you see that? 11:39:08
A. Yes. 11:39:11
Q. Is that something that you later explored? 11:39:17
A. Yes. Definitely I think that was as the thesis work of Dr. Yan. 11:39:19 11:39:29

Q. Turning to -- this is the appendix, looking at Pages 63 to 56 of Exhibit 8, do you understand this to be a summary of all experiments during Mr. Israel's thesis? 11:39:37 11:39:40 11:39:46 11:39:49
A. Yes. 11:39:54
Q. And let me just draw your attention to DP16b down here. We have both columns. We have the deposition time, average temp, temp range, pressure, methane concentration, growth rate in terms of milligrams per hour, C2-to-CH ratio and C2-to-hydrogen alpha ratio. 11:39:59 11:40:02 11:40:12 11:40:16 11:40:19 11:40:25
So for DP16, how long was the deposition? 11:40:28
A. I don't recall. I think his typical experiments were maybe a couple of hours with each sample. 11:40:40 11:40:43 11:40:47
Q. Based on the table, what is the deposition time? 11:40:50 11:40:54
A. Oh, okay. That says 13 and a half hours. 11:40:59
Q. Thirteen and a half hours. 11:41:03
And what was the average temperature? 11:41:05
A. He basically is taking that 1071 to 1195 and averaging 1170. 11:41:10 11:41:16
Q. So during the run, the temperature ranged from 1071 degrees C to 1195 degrees C? 11:41:19 11:41:20
A. Yes. 11:41:25

page 3 of Vohra Exhibit 10 -- it also mentions using the same stage of design producing a .6-millimeter thick diamond by adding a little bit of oxygen. 12:54:18 12:54:23 12:54:27
Do you see that? 12:54:32
A. Yes. 12:54:33
Q. And then you have lowered the growth temperature, keeping the rest of the conditions the same. 12:54:34 12:54:36 12:54:43
What happened when you tried to grow below a thousand degrees -- in these experiments when you tried to grow below 1000 degrees C without oxygen? What was the result? Do you remember? 12:54:44 12:54:46 12:54:49 12:54:53
A. I don't recall the specifics. But oxygen was known to remove graphite deposits. So it improves the crystalline quality. But the downside is that it reduces the growth rate. 12:55:02 12:55:07 12:55:10 12:55:14
Q. So without oxygen -- I'm sorry. 12:55:17
A. So using oxygen is kind of a balance between the quality and the crystal. 12:55:19 12:55:26
Q. So below a 1000 degrees C without oxygen, you grew spherical black diamond-like carbon? 12:55:30 12:55:34
A. That's right. 12:55:39
Q. But when you added oxygen, it allowed you to reduce the growth temperature and still get diamond; right? 12:55:39 12:55:41 12:55:44

A. Yes. 12:55:46
MR. LONG: All right. Let me introduce now Exhibit 11. 12:55:51 12:55:56
(DEPOSITION EXHIBIT 11 WAS MARKED FOR IDENTIFICATION.) 12:55:59 12:55:59
BY MR. LONG: 12:56:25
Q. I'm going to represent to you this was the Provisional Application filed for the 078 patent on November 7, 2001. And I'd like to direct your attention to page 6 of Exhibit 11, Figure 2. 12:56:26 12:56:29 12:56:36 12:56:43
Do you know what this is? 12:57:00
A. That is a substrate holder. 12:57:07
Q. Can you describe it for us, please. 12:57:12
A. There's a diamond seed in the center, and then there is a molybdenum sheet around it. 12:57:20 12:57:22
Q. Okay. And it's touching the sides of the diamond? 12:57:31 12:57:33
A. Yes. 12:57:33
Q. And the diamond seed is sticking out just a little bit above it? 12:57:37 12:57:40
A. Yes. 12:57:41
Q. So is this actually physically what is being described in the 078 patent, this design? 12:57:41 12:57:44
A. Yes. 12:57:56
Q. When you measured the substrate, how many 12:57:56

pyrometers did you use? 12:57:59
A. I don't recall those details. 12:58:07
Q. Did you use more than one? 12:58:09
A. I don't recall. 12:58:14
Q. Do you recall ever using more than one pyrometer to measure temperature in your lab? 12:58:20 12:58:22
A. Not at UAB. In UAB, we used only one pyrometer. 12:58:24 12:58:28
Q. Using one pyrometer at a single spot, can you determine a temperature gradient? 12:58:29 12:58:33
A. If you can focus on different areas, from the edges to the center to the other edge, you can get -- especially for a large substrate, you can get a temperature gradient. 12:58:40 12:58:44 12:58:46 12:58:51
Q. So you have to move -- I'm sorry. Go ahead. 12:58:53 12:58:55
A. So you can focus on different parts of a diamond crystal. If you have a large substrate and you have, you know, like a 2-millimeter focusing area, you can manually scan the surface and get an idea of the temperature gradient. 12:58:56 12:58:59 12:59:01 12:59:05 12:59:08
Q. So you have to physically move where the pyrometer is pointing? 12:59:10 12:59:13
A. Yeah. You can just move it and focus on different areas. 12:59:15 12:59:18

Q. Is that something you did as part of your process? 12:59:20 12:59:23
A. Yeah. We used to measure the temperature gradient all the time. 12:59:24 12:59:26
Q. Is that something you can control with the process parameters? 12:59:30 12:59:34
A. Repeat that question again, please. 12:59:40
Q. Is that something you can control by adjusting the microwave power or the gas flows or the pressure? 12:59:41 12:59:43 12:59:48
A. You mean the uniformity of the diamond temperature distribution? 12:59:50 12:59:54
Q. Correct. 12:59:55
A. I think it's a very complicated function of the heat sinking and the nth of power. So it's really hard to make a generalized statement. I think it really depends on the substrate holder design, which is critical in controlling the uniformity of temperature. 12:59:56 01:00:00 01:00:06 01:00:09 01:00:12 01:00:14
Q. Did you ever design any automatic control feedback loops that would adjust the temperature uniformity? 01:00:17 01:00:20 01:00:24
A. Yeah. We have experimented with, you know, changing the height of the diamond and have it grow bigger, you pull it down, and we have 01:00:33 01:00:33 01:00:38

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Q. So you talked earlier about how a two-color averages the temperatures within that little spot. Is that right? 01:49:07
A. Yes. 01:49:16
Q. Or roughly average. So my question is, if you're measuring, let's say, the center of a diamond with this pyrometer, will the pyrometer be able to tell you what the coldest point on the diamond is? 01:49:21
A. No. 01:49:48
Q. Because it's going to take an average; is that right? 01:49:49
A. Yes. 01:49:54
Q. Okay. Will it be able to tell you what the hottest point on the grill surface is? 01:49:57
A. Can you repeat the question? Are you doing measuring only at the center? 01:50:09
Q. No. Now let's say you move it to the edge. Okay? Will it be able to tell you what the hottest points on the edge is? 01:50:14
A. Sure. If you can do the scanning across the edges and you can definitely measure the gradient within that revolution of 2 millimeters, you can find the hot spot. With hot spots, you can also probably target visually -- usually they come back of the graphite formation on the edges. 01:50:24

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Q. So when you get kind of -- I will call it -- non-monocrystalline growth at the edges, that's a sign of a hot spot; is that correct? 01:50:57
A. I think this would be a very difficult determination to make because you may be getting non-diamond growth because it is not a (100) surface, so it may not necessarily be related to temperature. It could be that you have (111) surface exposed. 01:51:18
Q. All right. What if the non-monocrystalline growth is on the (100) surface. Then do you think it would be because of temperature? 01:51:47
A. It could be then because the temperature may be too high for -- temperature be too high there and graphite is nucleated, yeah. 01:51:59
Q. So the temperature is too hot at that location, and it's -- which is much hotter than the center of the diamond? 01:52:08
A. That's right. 01:52:21
Q. So I just want to go back to this example, briefly. Let's say you cite this pyrometer on a hot spot, and the hot spot is at -- you know, it's hot but it has multiple different temperatures in it. Okay? It has a range of temperatures in the hot spot. Will this pyrometer be able to tell you what the hottest temperature in that spot is? 01:52:26
A. No. It will only give you an average temperature. Because the way it works is it really is taking a ratio of the infrared light coming out and calculating. So you have really no way to find the maximal or minimal temperature. 01:52:58
Q. So let's say you poke this at the edge, and then you put this at the center, you might be getting a temperature gradient reading that is much too low because of this averaging; is that correct? 01:53:18
A. Yeah. It's definitely not accurate. 01:53:37
Q. Okay. All right. All right. So let me move on to Exhibit 11, which is the 078 patent. 01:53:41
I'm sorry. Maybe it's Exhibit 12. Yeah, it's Exhibit 12. I apologize. 01:54:06
So if you took this patent, what do you think the kind of -- the main thrust of the invention here was? 01:54:22
A. I think it was multipronged because of the gross chemistry substrate design of the holder. 01:54:34
Q. Okay. 01:54:46
A. Also some of the innovation was in terms of translation of the diamond stage. 01:54:48
Q. Okay. 01:54:53

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A. So it's really multiple levels. It's hard to say this one thing. 01:54:53
Q. Okay. Absolutely. I want to go to -- I want to jump to Claim 1 which is on page -- well, it's actually on page 18, the part I'm looking at. Let me -- I will zoom in for you. 01:55:00
Do you see that, those highlights? 01:55:38
A. Yes. 01:55:39
Q. Okay. So do you think this is something that all diamond -- I'm sorry -- that all MPCVD diamond chambers do? 01:55:43
A. It's really not just a question of the temperature reading; it's not just the diamond chamber; it also depends, of course, on the heat sink design at the substrate holder. 01:56:04
Q. Sure. Absolutely. 01:56:25
A. So I think there are innovations there which reduces this temperature gradient. So it's not just a generic block MPCVD system would do this. You have to, of course, have the appropriate substrate holder design to achieve that, to achieve the results. 01:56:27
Q. Right. Like the design shown in Fig. 2B? 01:56:48
A. Yes. 01:56:56
Q. Okay. So let's say that you have just 01:56:57

kind of the generic flat substrate design. It's just a big flat plate. If you saw that in the system, would you think that this -- that that system was capable of performing this?
A. In general, you have to really have appropriate design of heat sink for the diamond to achieve this.
Q. Right. But it -- I'm sorry?
A. It can get quite hot. So, yeah, an average chamber would not do that.
Q. Okay. Why will the edges get so hot if you're using a flat substrate holder?
A. I think it's a question of heat sinking the sides of the diamond crystal. So if the edges are freestanding, then there is a chance of having a thermal runaway, then you have some graphite formation which is conducting, and it's more like an antenna.
Q. What if you have -- scratch that. So do you think it would be possible to grow gem-quality-single-crystal diamond without doing this, performing this feature?
MS. FOWLER: Object to the form. Calls for speculation.
THE WITNESS: I really don't know whether

this is really a necessary condition. There may be other factors. So it's really hard for me to make any -- this definitely helps. But to say this is the only condition is also not -- not correct.
BY MR. LONG:
Q. So there are other ways of growing gem-quality single-crystal diamonds other than doing this?
A. Again, without knowing the details, I cannot say one way or the other.
Q. Okay.
A. It depends on the design of the reactor, design of the substrate holder, and definitely reducing the thermal gradient helps.
Q. Okay. Absolutely. Do you think that the reactors in your lab currently perform this functionality?
A. You know, we have several different reactors at UAB, so it depends on the design. And in some experiments, we can get that. But when we are growing the quality crystalline diamond, we really don't care about these temperature gradients; so in our homoepitaxial diamond growth experiments, we can get that.

Q. Okay. So let's talk about when you grow diamonds that are -- I will call it a large central crystal in the middle surrounded by polycrystalline diamond. I think you indicated that some of your experiments might produce that result; is that correct?
A. Yeah. Do you mean if we start with a single-crystal diamond and we have some polycrystalline growth at the edges?
Q. Yes. So you start with a single-crystal seed, and you grow upwards, and what you get is single-crystal in the center and polycrystalline surrounding it?
A. Yes. That can happen, yes.
Q. Okay. When that happens, do you think that the temperature difference between, you know, the coldest point and the hottest point on the growth surface was less than 20 degrees Celsius?
A. Again, it is -- you know, I cannot generalize for different CVD reactors and different designs.
Q. Sure.
A. So I cannot make an equal statement that this is really -- this is, of course, one way to have CVD Celsius temperature gradient, but there

could be other factors as well to grow CVD diamond. But what you are asking, if you don't have the degree, you will always get polycrystalline growth, I don't know about that.
Q. But let's say you do get, you know, a significant amount of polycrystalline growth.
A. That could be due to several reasons: One is the temperature. Another could be the geometry of the substrate as well. How many (inaudible) exposed to the plasma? That's really complicated situation to make a definitive statement.
Q. Absolutely. So when you're talking about the growth surface here, let's say you have a diamond with essential crystal surrounded by polycrystalline diamond. What would you consider the growth surface to be?
A. Most of the growth studies are done with one little bit of surface. So I would say that, you know, the growth surface, at least in the center part, is (100).
Q. Okay.
A. And so that's where, you know, most of the single-crystal diamond growth experiments are done.
And on (111) surfaces, you know, if you grow for a while, they always show cracking. So

Q. Okay. 02:13:01
A. This was not done in my lab, so I don't 02:13:02
want to make any inaccurate statements. 02:13:05
Q. Okay. That makes sense. I will stop 02:13:08
asking about it. 02:13:11
All right. I'm going to jump down to -- 02:13:19
this is Column 6 on page 13. And here I'm going to 02:13:26
highlight something. Can you read that sentence for 02:13:41
me, please? 02:13:52
A. "Precise control over growth surface 02:13:53
temperatures and growth surface temperature 02:13:55
gradients prevents the formation of polycrystalline 02:13:57
diamond or twins such that a large single crystal 02:14:02
diamond can be grown." 02:14:06
Q. So can you explain in different words what 02:14:08
you interpret that sentence to mean? 02:14:12
A. What it really means is that -- I think we 02:14:18
have been discussing during this deposition the 02:14:28
surface temperature control either through microwave 02:14:31
power adjustments or to, you know, the diamond stage 02:14:36
and cross process can be controlled. 02:14:42
Q. Sure. 02:14:45
A. And the surface gradient can be controlled 02:14:45
by a proper heat sink design of the substrate hold. 02:14:48
So those are really the two key innovations in this 02:14:54

patent. That's what it really means in a nutshell. 02:14:58
Q. Sure. And so what -- I guess -- I'm 02:15:02
trying to get to the second portion of this sentence 02:15:06
where it talks about "prevents the formation of 02:15:09
polycrystalline diamond or twins." 02:15:11
Do you see that? 02:15:17
A. Yes. So unless those conditions are not 02:15:18
satisfied -- as explained in this patent, you can 02:15:22
get polycrystalline growth, and that is a limiting 02:15:31
factor for growing large crystals. 02:15:35
Q. So if you had -- would it be accurate to 02:15:39
say that if you have polycrystalline diamonds or 02:15:45
twins, you didn't exert precise control over growth 02:15:52
surface temperature gradients? Would that be 02:15:58
correct? 02:16:02
A. And if your plasma chemistry is not 02:16:04
correct. If you have too much carbon -- so, again, 02:16:08
I think this is really a multivariable thing. It's 02:16:12
hard to pin down on the temperature gradient and the 02:16:18
unique form of temperature. Your plasma chemistry 02:16:21
also has to be correct for single-crystal growth. 02:16:27
So it's combined with the plasma chemistry. 02:16:30
Q. So if we could just focus on these. Are 02:16:47
you trying to say that you need -- in order to 02:16:56
control all temperature gradients to less than or 02:17:00

equal to 20 degrees Celsius, you would need to have 02:17:06
precise control over the microplasma and good heat 02:17:09
sinking? Is that what you're saying? 02:17:17
A. I'm saying these two things that you have 02:17:19
highlighted, these are the necessary conditions, but 02:17:20
they are not sufficient. You have to have the right 02:17:24
plasma chemistry in addition to having these two 02:17:29
things. So I'm saying these are necessary 02:17:32
conditions, but they are not sufficient. 02:17:34
Q. Okay. Are you saying that you need to 02:17:38
have precise control over growth surface temperature 02:17:40
gradients to grow gem-quality diamonds? 02:17:44
A. Yes. 02:17:47
Q. Okay. How would you know if someone had 02:17:52
precise control over the temperature gradients? 02:17:56
A. I think that's really -- you have to 02:18:03
really come up with a spatial resolve measurements 02:18:05
of the substrate temperature. And there are -- they 02:18:08
have to have better than 2 millimeters -- basically 02:18:19
you are measuring the black body radiation coming 02:18:23
out of -- so if you -- in principle, you can scan 02:18:26
the entire surface and get a good temperature 02:18:30
control or temperature measurement. 02:18:33
Q. Okay. So are you saying that in order to 02:18:36
perform control over growth surface temperature 02:18:39

gradients, you would need to perform temperature 02:18:43
gradient measurement? 02:18:48
A. Yes. Yes, you have to correct the 02:18:54
temperature gradients and monitor that temperature 02:18:57
during that entire gross run. 02:19:00
Q. Okay. So you need to measure the 02:19:04
temperature gradients throughout the entire growth 02:19:07
run, is that -- 02:19:10
A. Yes. And also control the absolutely 02:19:12
average temperature over time. 02:19:15
Q. Right. Okay. So down here it says 02:19:20
that -- let me delete this. Here it says "The 02:19:45
ability to control all temperature gradients across 02:19:53
the growth surface is influenced by several 02:19:55
factors," and it lists some factors and then it 02:20:00
talks about the detection capabilities of the 02:20:05
infrared pyrometer. 02:20:08
Do you see that? 02:20:10
A. Yes. 02:20:19
Q. Okay. So can you explain what the patent 02:20:19
is saying there? 02:20:25
A. Again, you know, I'm not familiar with, 02:20:30
you know, the spatial revolution of the pyrometer at 02:20:33
Carnegie; so I cannot really say with certainty that 02:20:43
you can -- it boils down to the spatial resolution 02:20:51

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holder?
A. Yeah. That's what it would imply.
Q. Okay. Sure. Now, I want to go to -- oh, let me ask you a question. Is there a difference in surface morphology between single-crystal diamond and polycrystalline diamond?
A. Yes.
Q. Okay. So now I'm going to go to the same document. I'm going to go to Paragraph 152. It talks about temperature gradient and heat-sinking holder.
Do you see that?
A. Yes.
Q. Okay. Now, it lists a few temperature gradients across the growth surface. It says less than 100, less than 50, 40, 30, 20, 10.
A. Yes.
Q. Okay. What would a diamond with a temperature gradient across the growth surface of 100 degrees Celsius look like compared to one with 10 degrees Celsius?
A. I really don't recall those details.
Q. Okay. So do you remember if you grew a diamond with a temperature gradient of 100 degrees Celsius?

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A. I don't remember those details.
Q. So I just want to go back to -- so this sentence here: "This results in samples with a widely varied surface morphology indicating an uneven thermal gradient across the surface."
So if you had a diamond that had kind of a large crystal in the center and polycrystalline diamond on the sides, would that indicate a widely varied surface morphology?
A. Not necessarily. Because you could have the center portion small with (100) growth, and then on the edges, you may have -- so your surface morphology in the center may be very small, but you still have polycrystalline on the outside.
Q. What about the transition region between the single-crystal in the center and the polycrystal on the side?
A. That would be a case of a different morphology.
Q. So that would be a case of different surface morphologies? Is that what you said?
A. Yes. That's correct.
Q. Okay. Great. So let's say you want -- going back to Paragraph 152, but let's say you wanted to achieve a temperature gradient across the

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growth surface of less than 20 degrees or 10 degrees or even -- let's say less than 30 degrees. What do you think you would require in order to accomplish that?
A. I think it would be the substrate holder design.
Q. The one that contacts the diamonds on their sides?
A. Correct. Yes.
(DEPOSITION EXHIBIT 103 WAS MARKED FOR IDENTIFICATION.)
BY MR. SNOW:
Q. Okay. So now I want to go Exhibit 103.
Dr. Vohra, is this -- are you an author of this paper?
A. Yes, I am.
Q. Okay. And is Chih-shiue Yan, is he a co-inventor of the 078 patent?
A. Yes, he is.
Q. And did you write this paper together?
A. Yes, we did.
Q. Okay. So let's go down. And I know you have kind of seen maybe a little bit lower-quality versions of these pictures earlier today because I think that some of these were in the Yan

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dissertation. But I wanted to talk about some of these pictures, if that's okay with you.
A. Okay.
Q. So, first, I want us to look at this diamond, DRUK1.
A. Okay.
Q. So is this area in the center all one big crystal?
A. It is.
Q. Okay. What's the black stuff around the edges?
A. Most likely some graphite nucleation.
Q. Okay. Is this -- in your experience, is this kind of a pretty good surface morphology or a poor one?
A. I would say if you go up, DRUK2, that's a better one.
Q. This one?
A. Yes. Because you can see, you are beginning to develop -- remember, this is a circular plate, so you have the upper edges which are (100) surface on the side. So this one has a much better morphology than the other one.
Q. Okay.
A. So out all of these pictures, this is the

amount of twinning and polycrystalline growth on the side here? 03:15:05 03:15:09
A. Yes. 03:15:10
(DEPOSITION EXHIBIT 105 WAS MARKED FOR IDENTIFICATION.) 03:15:10 03:15:10
BY MR. SNOW: 03:15:11
Q. Okay. So now let me jump to Exhibit 105. And so are you familiar with this paper? 03:15:11 03:15:20
A. I looked at it when I got it from my attorney, David Mellon, yesterday. 03:15:33 03:15:36
Q. Did you have any thoughts on it? 03:15:41
A. I didn't spend much time reading it, but I'm aware of this group's work. 03:15:46 03:15:51
Q. Okay. So let's talk about Figure 2 here. Do you think that these show grown diamonds? 03:16:00 03:16:10
A. They're all -- of course they are all CVD grown, but at this resolution it is difficult to say that, you know, they are monocrystalline or not. 03:16:19 03:16:22 03:16:24
Q. Why might they be non-monocrystalline? 03:16:31
A. Again, I don't see any X-ray data on this paper. So that's the commonality. 03:16:39 03:16:43
(DEPOSITION EXHIBIT 106 WAS MARKED FOR IDENTIFICATION.) 03:16:47 03:16:47
BY MR. SNOW: 03:16:48
Q. Okay. Makes sense. So let's skip this 03:16:48

and go straight to Exhibit 106. Let me start at the top. Are you familiar with this paper? 03:16:51 03:16:58
A. Again, I got it from the attorney yesterday and I really have glanced through it. 03:17:04 03:17:10
Q. Okay. No problem. So I'm not going to talk about this in detail, but it's just some pictures here, Figure A and Figure B or Fig. 2-A and Fig. 2-B. What do you see here in these photographs and what are the differences between them if you're able to see any? 03:17:15 03:17:19 03:17:22 03:17:34 03:17:39 03:17:42
A. Well, not knowing much else, I would -- it appears that the "B" is of higher quality growth. 03:17:51 03:17:54
Q. So does A have in the uneven surface morphology around its edge? 03:18:01 03:18:07
A. Yes. 03:18:14
Q. What would that be evidence of while it was growing? Or what would that tell you about his growth conditions? 03:18:15 03:18:20 03:18:37
A. I really cannot comment without really knowing all of the details about their -- 03:18:39 03:18:43
Q. Okay. No problem. 03:18:51
A. -- details about their substrate holders and their chemistry and all of the other details. 03:18:54 03:18:58
(DEPOSITION EXHIBIT 107 WAS MARKED FOR IDENTIFICATION.) 03:19:01 03:19:01

BY MR. SNOW: 03:19:02
Q. Okay. No problem. Jumping straight ahead to Exhibit 107 and same questions. 03:19:02 03:19:05
Are you familiar with this paper or these authors? 03:19:13 03:19:16
A. Not a great familiarity. Again, I got this from my attorney yesterday. 03:19:22 03:19:28
Q. Okay. No problem. So I'm not going to go to the text. Instead, we will go to this diamond, Figure 10. You can see that. And now admittedly we're understanding you're not familiar with this paper. But given this diamond, what would you say about its surface morphology? 03:19:30 03:19:31 03:19:49 03:19:56 03:19:58 03:20:02
A. This one looks like good surface morphology. You see sharp edges on the outside; so not that much evidence of polycrystalline growth. 03:20:05 03:20:15 03:20:18
Q. And would that indicate that at least possibly that the temperature gradient on the gross surface was small during growth? 03:20:24 03:20:28 03:20:33
A. Yes. 03:20:38
Q. Okay. Now, just briefly jumping back up to this one. Same questions about this diamond. What do you notice about its surface morphology? 03:20:42 03:20:47 03:20:58
A. Obviously, you know, it is kind of rough at the edges, polycrystalline growth. Yeah. So 03:21:02 03:21:04

definitely a lot different than the one you showed before. 03:21:12 03:21:15
Q. Right. And what would this tell you -- what would this surface morphology tell you about the temperature gradient during growth? 03:21:18 03:21:23 03:21:28
A. Again, I think I would clearly -- without really knowing all of the details about the chemistry and the holder design for different shapes from here, I really cannot comment on that. 03:21:38 03:21:44 03:21:46 03:21:50
Q. Okay. And this is, just quickly, the last series of questions. 03:21:54 03:21:59
So you mentioned here that you would need to know about the holder design in order to comment on the temperature gradient. Is that what you said? 03:22:02 03:22:07 03:22:11
A. Yes. 03:22:18
Q. So what would you need to know about the holder? 03:22:18 03:22:20
A. Not just with the holder design, but also the reactor design, the cooling capacity, and gaseous chemistry; so I think it's hard to really extrapolate just with one variable about the temperature gradient. 03:22:26 03:22:29 03:22:36 03:22:41 03:22:44
Q. Sure. But you mentioned the holder design specifically. Would it be important for you to know whether it's a side contact holder versus an open 03:22:47 03:22:51 03:22:57

holder? 03:23:02
A. Yes. That's correct. That would be one 03:23:03
thing that you would like to know right away. 03:23:05
Q. In order to know whether the temperature 03:23:08
gradients were low during growth; is that correct? 03:23:10
A. Yes. 03:23:14
MR. SNOW: Okay. Thank you very much, 03:23:20
Dr. Vohra. I think Leydig would like to 03:23:22
reserve a few minutes for Cross based on this 03:23:28
follower's questions, but that's all I have for 03:23:33
now. Thank you very much for your time. 03:23:36
MS. FOWLER: If we could take a quick 03:23:56
5 minutes for me to get my notes in order. Is 03:23:58
that okay with everyone? 03:23:58
THE VIDEOGRAPHER: The time is 3:23, and 03:24:00
we are off the record. 03:24:02
(A BRIEF RECESS WAS HELD.) 03:24:03
THE VIDEOGRAPHER: The time is 3:30 p.m., 03:30:35
and we are on the record. 03:30:36
EXAMINATION 03:30:40
BY MS. FOWLER: 03:30:40
Q. Hello again, Dr. Vohra. I'm Sarah Fowler. 03:30:41
I represent the plaintiff Carnegie. Thank you very 03:30:45
much for your time. I just a few quick questions, 03:30:49
and I will try to make this brief. 03:30:52

Is my screen share working? Can you see 03:31:50
that? 03:31:54
A. Yes, I can. 03:31:55
THE COURT REPORTER: Excuse me. 03:31:55
(A DISCUSSION WAS HELD OFF THE RECORD.) 03:31:55
BY MS. FOWLER: 03:32:48
Q. Okay. Sorry for the interruption, 03:32:51
Dr. Vohra. I'd just like to direct your attention 03:32:53
to Column 6 of the 078 patent here. And 03:32:59
specifically at line 55 here. It's discussing 03:33:07
controlling the temperature gradients. And it says 03:33:11
"The ability to control all of the temperature 03:33:13
gradients across the growth surface of the diamond 03:33:16
136 is influenced by several factors, including the 03:33:19
heat-sinking capability of the stage 124, the 03:33:22
positioning of the top surface of the diamond in the 03:33:26
plasma 141, the uniformity of the plasma 141 that 03:33:28
the growth surface of the diamond is subjected to, 03:33:33
the quality of thermal transfer from edges of the 03:33:35
diamond via the holder or sheath 134 to the stage 03:33:38
124, the controllability of the microwave power, 03:33:42
coolant flow rate, coolant temperature, gas flow 03:33:44
rates, reactant flow rate, and the detection 03:33:48
capabilities of the infrared pyrometer 142." 03:33:52
Would you agree, Dr. Vohra, that these are 03:33:56

all factors that can influence the temperature 03:33:59
gradients on the growth surface? 03:34:00
A. Yes, I do. 03:34:05
MS. FOWLER: And can I ask you, J.P. or 03:34:08
someone, are you able to put up -- there's an 03:34:10
exhibit I did not have access to. My Internet 03:34:12
was out. It's Exhibit 5. Would someone else 03:34:15
be able to pull that up for me? 03:34:17
MR. SNOW: This is Max. I can pull it up. 03:34:31
Do you want me to start sharing my screen? 03:34:35
MS. FOWLER: That would be great. If you 03:34:38
wouldn't mind pulling up Exhibit 5, and we will 03:34:39
be going to page 22. 03:34:42
MR. SNOW: Okay. Give me a second. 03:34:44
MS. FOWLER: Appreciate it. Thank you. 03:34:46
MR. SNOW: Sure. So page 22? 03:34:48
MS. FOWLER: Page 22, that's right. 03:34:56
BY MS. FOWLER: 03:35:00
Q. This is Vohra Exhibit 5. Dr. Vohra, can 03:35:00
you just describe what is in Figure 1.3, please? 03:35:06
A. Yes. So this one has a 1.2-kilowatt 03:35:09
microwave power supply. It has a coupler which 03:35:13
couples the microwave to the chamber below. And it 03:35:19
has that two-color pyrometer for measuring the 03:35:24
diamond temperature. 03:35:30

Q. And is this the same equipment setup that 03:35:31
you testified about earlier today? 03:35:33
A. Yes. 03:35:35
Q. Great. And the pyrometer, it's labeled 03:35:36
two-color optical pyrometer. That's to the right in 03:35:40
blue; is that correct? 03:35:44
A. Yes. 03:35:44
Q. Can you tell me what is the approximate 03:35:46
distance between the pyrometer and the reaction 03:35:49
chamber? 03:35:51
A. It would be approximately about 03:35:53
45 centimeters. 03:35:59
Q. And did that distance vary at all or has 03:36:03
the pyrometer been at the same distance since you 03:36:05
initially set up the lab to the present? 03:36:09
A. It has been at the same distance. We 03:36:12
don't change the location. The only thing that we 03:36:14
do is, depending on the substrate, we adjust the 03:36:15
focus a little bit. So the distance is not changed. 03:36:18
Q. And how do you adjust the focus? 03:36:21
A. Actually control at the back of the 03:36:25
pyrometer which can adjust the focus so you can 03:36:27
focus on different substrates. 03:36:30
Q. Great. And then the pyrometer is aimed at 03:36:33
what looks to be a viewing window? Is that what you 03:36:36

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A. Yeah. That's contained in the substrate design, where there's the pressure at which you squirt the coolant at the back of the stage.
Q. At the back of the stage? So in your view, the patent describes how to increase the coolant flow?
A. Again, you know, without -- I have to really read it very carefully to make a statement like that.
Q. Do you remember inventing a way to improve the coolant temperature?
A. The coolant temperature -- I mean, you can use different materials for cooling and different liquids which have different feeding points; so that's -- that's one way to do this.
Q. And did you describe those in the patent?
A. Again, I cannot comment until I really look at it carefully.
Q. How do you get the coolant temperature? Does the chiller do that?
A. I mean, you can set -- basically, you can generate heat if you want higher temperatures. There's a coil which controls the coolant temperature.
Q. Just so I understand, you control the

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coolant temperature by putting a setting into the chiller; correct?
A. That's right. Basically that's a small heating coil which changes the temperature.
Q. Did you invent a new chiller?
A. No. No. But I'm just saying that that's one way to modify, you know, the cooling characteristics.
Q. Was that new to people? Did they not know how to do that?
A. No. That is an established technology. The coolant -- the chiller and those are established technologies.
Q. Right.
A. The power rating and for a given application is what we adopt to a specific reactor.
Q. Okay. Just one more quick question about the sentence before. It says "Precise control over the growth surface temperatures and growth surface temperature gradients prevents formation of polycrystalline diamond, or twins, such that a large single-crystal diamond can be grown."
Is there a difference in surface temperatures and growth -- excuse me. Is there a difference in growth surface temperatures and growth

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surface temperature gradients?
A. Yeah. One is referring to, you know, the absolute temperature, and another is referring to the gradient, which is how much per micron of the surface the temperature changes if you move along one axis; so one is an absolute value and the other is the gradient with respect to the distance.
Q. Sorry. Didn't mean to interrupt you.
A. These are two different quantities. One is the absolutely temperature. One is what we called Delta D, Delta R which is the gradient of the temperature.
Q. And that's measured in -- so surface temperature is measured in degrees C; correct?
A. That's right.
Q. And temperature gradient is measured in --
A. C per micron or per 100 micron.
Q. Is it fair to say that the temperature of the growth surface is what you're measuring with the pyrometer at a single spot?
A. Yes.
Q. And the temperature gradient would be the difference in temperature over the surface; correct?
A. That's correct.
Q. So when you're talking here in this

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sentence about controlling the temperature, what you're talking about is the absolute temperature as a function of time. Is that right?
A. That's correct.
Q. And how do you adjust the absolute temperature as a function of time?
A. Absolute temperature as a function of time is by adjusting either the microwave power or changing the sample height. Those are the two simpler ways of doing it.
Q. And how do you control the growth surface temperature gradient?
A. That will be with the heat sinking.
Q. Okay.
A. By the design that is described in the patent.
Q. The design with the thermal contact at the edges?
A. Yes.
Q. Okay. All right. I will let -- I think I'm finished. I will let Max ask if he has any further questions.
EXAMINATION
BY MR. SNOW:
Q. Dr. Vohra I have one kind of quick

question. I'm going to share my screen also. 04:08:57
So I'm going to Exhibit 55. I think you 04:09:11
might have seen this briefly today. But do you 04:09:18
recognize this document? 04:09:22
A. Yes. It is Ph.D. thesis of my student 04:09:24
Dr. Samudrala. 04:09:28
Q. And I'm going now to page 53 of the thesis 04:09:36
which is page 67 of the Exhibit. 04:09:56
Are you there? 04:10:05
A. Yes. 04:10:06
Q. Can you read this sentence and tell me 04:10:09
what it means? 04:10:11
A. "Any small variation in growth conditions 04:10:13
can lead to huge changes in the behavior of growth 04:10:16
radicals in the plasma near the substrate surface, 04:10:18
and it is nearly impossible to account for all 04:10:21
possible changes in a theoretical explanation." 04:10:23
Q. What does that mean to you? 04:10:31
A. I think it is a graduate student. They 04:10:35
are saying that it is a complicated multiparameter 04:10:39
problem. 04:10:42
MR. SNOW: Okay. That's all the questions 04:10:48
I have. So I don't know -- unless, Sarah, you 04:10:50
wanted to ask something more? 04:11:05
Sarah, we can't hear you, but you shook 04:11:11

your head, so I'm guessing that means no. 04:11:13
MS. FOWLER: You're correct. There's 04:11:17
nothing further from plaintiffs. 04:11:18
Thanks. 04:11:19
MR. SNOW: Then I think we're finished. 04:11:23
Thank you very much for your time, Doctor. 04:11:26
THE WITNESS: Thank you very much. 04:11:28
THE VIDEOGRAPHER: I'll do a quick 04:11:33
read-off, and then we will be okay. 04:11:34
Today is July 31, 2020. The time is 04:11:38
4:11 p.m. This completes today's deposition of 04:11:40
the Yogesh Vohra, and we are off the record. 04:11:45
(THE DEPOSITION OF YOGESH K. VOHRA, Ph.D.,
WAS CONCLUDED AT 4:11 P.M.)

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C E R T I F I C A T E
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MOBILE COUNTY)

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